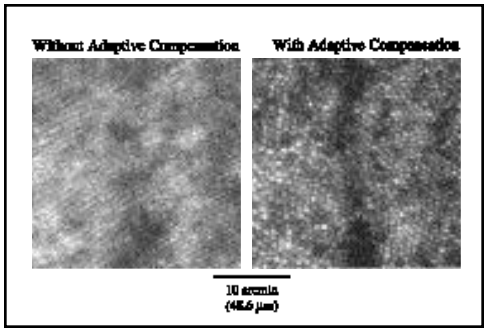
DEFORMABLE MIRRORS TO UNCOVER EYE DISORDERS



● *Deformable mirrors help researchers take a closer look at diseased retinas.*

Approximately 80 percent of premature infants weighing less than 1 kilogram at birth will develop retinopathy of prematurity (ROP). Children with ROP are diagnosed with retinal scarring, nearsightedness, and crossed or "wandering" eyes at a much higher incidence than normal-weight infants.

BMDO HISTORY

Xinetics, Inc. (Littleton, MA), is using adaptive optics technology developed for BMDO to bring optical correction and precision to a medical imaging application. BMDO funded the original research primarily for the ground-based free electron laser, whose beams were subject to atmospheric distortion. With research and development funded by BMDO, the U.S. Navy's Office of Naval Research, and the U.S. Air Force's Phillips Laboratory, Xinetics' core team developed lead magnesium niobate (PMN) actuators and deformable mirror technology at Itek Corporation and United Technologies Optical Systems.

HOW IT WORKS

Adaptive optics is an aggregate technology that analyzes the characteristics of light waves and minimizes their distortion. The two principal corrections are for the "tilt" of the light entering the optical system and for the light scatter caused by collisions with molecules in the atmosphere or in the vitreous fluid of the eye, for example. An adaptive optics system uses a wavefront sensor to measure the optical distortion and supply a control computer with an error map. The computer then sends commands to a deformable mirror that changes shape to correct the distortion. Deformable mirrors use small piston-like devices called actuators to bend a thin sheet of polished ultralow-expansion fused-silica glass.

The key elements in the Xinetics deformable mirror technology are piezoelectric or electrostatic actuators based on PMN crystals. These actuators expand and contract when an electric field is applied, pushing and pulling the mirror sections into different shapes. PMN actuators are well suited to deformable mirrors because of their high stiffness, negligible hysteresis, and excellent stability. To produce PMN actuators in high volumes, Xinetics uses a layered ceramic process developed in the microelectronics and multilayer capacitor industries. The process eliminates conventional glue bonding to provide high stiffness. It also reduces operating voltage from 3,000 to 100 volts.

MEDICAL SIGNIFICANCE

A Xinetics deformable mirror is now part of a retinal camera being developed by David R. Williams, Ph.D., the director of the University of Rochester's Center for Visual Science. The camera already provides a twofold improvement in resolution over present ophthalmic imaging devices such as the fundoscope. The resolution of the retinal camera is currently 2 to 10 micrometers and is expected to eventually reach 0.3 micrometers. The camera can provide detailed images of photoreceptors in the retina and can detect early changes in disorders like diabetic retinopathy and retinitis pigmentosa. It can also be used to more precisely measure refractive error (the degree of nearsightedness or farsightedness) in the eye. Microaneurysms, or small balloon-like lesions of capillaries, can also be diagnosed. Microaneurysms can reflect the presence of more serious blood vessel disorders in the brain. Developmental progress of neonatal eyes can also be tracked with this device. Retinopathy due to oxygenation of immature retinal cells is an increasing problem in premature infants, particularly as gestational age at birth decreases.

VENTURES OR PRODUCT AVAILABILITY

Xinetics, a 15-person company founded in 1993, makes custom and standard adaptive optics technologies for military and commercial customers. The company is engaged in a number of agreements to manufacture deformable mirrors and actuators for medical applications, astronomical telescopes, optical scanners, and micropositioners.

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